APPENDIX C. DATA MANAGEMENT PLAN

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Tables

Acronyms

AET	apparent effects threshold
AOC	Administrative Order on Consent
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	cleanup screening level
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
EPA	US Environmental Protection Agency
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
HpCDD	heptachlorodibenzo-*p*-dioxin
HpCDF	heptachlorodibenzofuran
HxCDD	hexachlorodibenzo-*p*-dioxin
HxCDF	hexachlorodibenzofuran
LAET	lowest apparent effects threshold
LDW	Lower Duwamish Waterway
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
OCDD	octachlorodibenzo-*p*-dioxin
OCDF	octachlorodibenzofuran
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PeCDD	pentachlorodibenzo-*p*-dioxin
PeCDF	pentachlorodibenzofuran
PEF	potency equivalency factor
QC	quality control
RI/FS	remedial investigation/feasibility study
RL	reporting limit
SCO	sediment cleanup objective
SIM	selected ion monitoring
SMS	Washington State Sediment Management Standards
SQS	sediment quality standards

SVOC	semivolatile organic compound
TCDD	tetrachlorodibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
TEF	toxic equivalency factor
TEQ	toxic equivalent
TOC	total organic carbon
WAC	Washington Administrative Code
WHO	World Health Organization

1 Introduction

This appendix presents the data management plan for the pre-design studies project. It contains two main sections:

- Section 2. Project database structure and data usability
- Section 3. Data management rules

2 Project Database Structure and Data Usability

The project database published with the Lower Duwamish Waterway (LDW) remedial investigation/feasibility study (RI/FS) is a Microsoft Access® database containing sediment, water, and tissue chemistry data for samples collected between 1990 and 2010. This section describes planned revisions to the project database structure; the incorporation of new in-waterway, upstream, and source control-related data compiled under Task 2;[1] and the process for future data additions.

2.1 Project Database Structure Revisions

The existing project database stores the RI/FS chemistry data in six media-specific tables: surface sediment, subsurface sediment, tissue, surface water, porewater, and seeps. In order to simplify usage and management of these data, the existing six tables will be consolidated into three tables containing in-waterway data of similar media types: sediment chemistry, tissue chemistry, and water chemistry.

The surface sediment and porewater tables in the existing project database are provided in two forms: one that includes field replicates as discrete samples ("sample-averaged"), and one that provides the average concentration of the parent and field replicate sample for each chemical ("location-averaged"). In order to reduce redundancy and simplify usage of these data, the updated database will present all data on a sample-averaged basis, with field replicates included as discrete samples and clearly identified.

2.2 Incorporation of Task 2 Data

The data compiled under Task 2 includes in-waterway, upstream, and source control-related samples collected between 2010 and 2016. These in-waterway data will be incorporated into the sediment, tissue, and water tables, as described in Section 2.1. The upstream and source control-related data will be added to the project database as five new tables: storm drain and combined sewer system source tracing solids, bank soils, groundwater, upstream surface water, and upstream suspended solids.

[1] Task 2 of the pre-design studies outlined in the third amendment to the Administrative Order on Consent (AOC) (EPA 2016).

2.3 DATA ADDITIONS

Chemistry data from each pre-design study sampling event will be incorporated into the project database following receipt of validated data. In addition, as appropriate, additional in-waterway data unrelated to the pre-design studies will be added as they are made available.

New data will be incorporated into the media-specific tables described in Sections 2.1 and 2.2. Prior to incorporating these data into the database, the new data will be assessed for quality and usability using the data quality review process described in the Task 2 data compilation memo (Windward and Integral 2017).

Additions and revisions to the project database will be documented in a change log table within the Microsoft Access® database. A list of all data additions following the Task 2 compilation will be included in Task 6, the data evaluation report. A final version of the Microsoft Access® project database will be submitted to the US Environmental Protection Agency (EPA) at the end of the project.

2.4 DATA USABILITY

Although the RI/FS and data compiled under Task 2 will be combined for ease of use, these two datasets were originally compiled using different approaches, and the following caveats should be considered during use:

- Preparation of the RI/FS dataset included a spatial and temporal evaluation process that allowed newer data to override older co-located results. This process was conducted for the RI/FS dataset to show the most recent results. No equivalent process was applied to the Task 2 dataset.
- The compilation work for Task 2 specifically excluded pre-cleanup surface and subsurface sediment data from areas that have been dredged or otherwise remediated, so the dataset does not represent all in-waterway data collected between 2010 and 2016.
- The updated in-waterway sediment table will provide a comparison to current Washington State Sediment Management Standards (SMS) criteria, as appropriate. These criteria have been revised since the RI/FS dataset was originally published,[2] so the screening outcomes will not match those previously reported.
- In the RI/FS surface sediment dataset, a single averaged concentration was reported for each chemical at locations that had a field replicate sample. In merged RI/FS and Task 2 datasets for sediment, both parent and field replicate

[2] Some dry weight apparent effects thresholds (AETs) have changed, as well as the total organic carbon (TOC) threshold for carbon normalization.

results for each location will be provided; maps will present the parent sample result instead of an average.

These data usability considerations will be noted in a reference table in the project database, and the data source for each sample (e.g. RI/FS, Task 2) will be clearly identified in each of the chemistry tables.

3 Data Management Rules

Data management rules being followed for the pre-design studies are the same as those applied to the RI/FS dataset, except as noted in this section. Rules summarized in this appendix include those for averaging duplicate or replicate samples (Section 3.1), selecting the preferred result if more than one result is reported for a chemical (Section 3.2), handling significant figures and rounding (Section 3.3), calculating totals when results are summed for individual components (Section 3.4), calculating toxic equivalents (TEQs) for polychlorinated biphenyl (PCB) congeners and dioxin/furan congeners (Sections 3.5 and 3.6, respectively), and calculating carcinogenic polycyclic aromatic hydrocarbons (cPAHs) (Section 3.7).

3.1 Averaging Laboratory Duplicate or Replicate Samples

Contaminant concentrations obtained from the analysis of laboratory duplicates or replicates (i.e., two or more analyses on the same sample) will be averaged for a closer representation of the "true" concentration than that provided by the results of a single analysis. Averaging rules will be dependent on whether the individual results are detected concentrations or reporting limits (RLs) for non-detected analytes. If all concentrations are detected for a given parameter, the values will be simply averaged arithmetically. If all concentrations are non-detected for a given parameter, the minimum RL will be reported. If the concentrations are a mixture of detected concentrations and RLs, any two or more detected concentrations will be averaged arithmetically, and RLs will be ignored. If there is one detected concentration and one or more RLs, the detected concentration will be reported. The latter two rules will be applied regardless of whether the RLs are higher or lower than the detected concentration.

3.2 Selection of Preferred Results

In some instances, the laboratory will generate more than one result for a chemical for a given sample. Multiple results can occur for several reasons, including:

- The original result does not meet the laboratory's internal quality control (QC) guidelines, and a reanalysis is performed.
- The original result does not meet other project data quality objectives, such as a sufficiently low RL, and a reanalysis is performed.

- Two different analytical methods are used for that chemical.

In each case, a single result will be selected for use. The procedures for selecting the preferred result will differ depending on whether a single or multiple analytical methods are used for that chemical.

For the same analytical method, the results will be selected using the following guidance:

- If the results are detected and not qualified, then the result from the lowest dilution will be selected, unless multiple results from the same dilution are available, in which case the result with the highest concentration will be selected.
- If the results are a combination of estimated and unqualified detected results, then the unqualified result will be selected. This situation most commonly occurs when the original result is outside of the calibration range, thus requiring a dilution. The diluted result within the calibration range will be preferentially selected.
- If the results are all estimated, then the result will be selected using best professional judgment and considering the rationale for qualification. For example, a result qualified based on laboratory replicate results outside of QC objectives for precision will be preferred to a qualified result that is outside the calibration range.
- If the results are a combination of detected and non-detected results, then the detected result will be selected. If there are more than one detected result, the applicable rules for multiple results (as discussed above) will be followed.
- If the results are all non-detected, then the lowest RL will be selected.

For different analytical methods (i.e., when a specific chemical is analyzed in the same sample using different methods), the following rules will be applied:

- For results analyzed using the semivolatile organic compound (SVOC) full-scan (EPA 8270) and selected ion monitoring (SIM) (EPA 8270-SIM) methods, the SIM results will be selected.
- For results analyzed using EPA Method 8081A and any 8270 method (i.e., hexachlorobenzene and hexachlorocyclopentadiene), the 8081A result will be selected.

The RI/FS database rules for the selection of preferred results between two methods (as described above) are revised for the compilation of the pre-design data. In the RI/FS, the preferred result was selected based on a comparison between the methods of the detection status, RL, and data qualifiers. The revised rules select the preferred result based on a preference for method.

3.3 SIGNIFICANT FIGURES AND ROUNDING

The analytical laboratories report results with various numbers of significant figures depending on the instrument, parameter, and concentration relative to the RL. The reported (or assessed) precision of each observation will be explicitly stored in the project database as a record of the number of significant figures assigned by the laboratory. The tracking of significant figures will become important when calculating averages and performing other data summaries.

When a calculation involves addition, such as totaling PCBs or polycyclic aromatic hydrocarbons (PAHs), the calculation will be only as precise as the least precise number that goes into the calculation. For example (assuming two significant figures):

> 210 + 19 = 229 will be reported as 230 because 19 is only reported to 2 significant digits, and the enhanced precision of the trailing 0 in the number 210 is not significant.

When a calculation involves multiplication or division, such as carbon normalization, the original figures for each value are carried through the calculation (i.e., individual values are not adjusted to a standard number of significant figures; instead, the appropriate adjustment is made to the resultant value at the end of the calculation). The result is rounded at the end of the calculation to reflect the value with the fewest significant figures used in the calculation. For example:

> 59.9 x 1.2 = 71.88 will be reported as 72 because there are 2 significant figures in the number 1.2.

When rounding, if the number following the last significant figure is less than 5, the digit will be left unchanged. If the number following the last significant figure is equal to or greater than 5, the digit will be increased by 1.

3.4 CALCULATING TOTALS

Total PCBs, total dichlorodiphenyltrichloroethanes (DDTs), total PAHs, total chlordane, total xylenes, and total nitrosamines will be calculated by summing the detected values for the individual components (e.g., Aroclor mixtures or individual congeners for total PCBs). For samples in which none of the individual components are detected, the total value will be given as the highest RL of any individual component, and assigned a U-qualifier (no detected concentrations). No sum will be calculated in cases where 50% or less of the components are analytes. Concentrations for analyte sums will be calculated using the following components:

- Total PCBs will be calculated, in accordance with the methods of the SMS, using only detected values for all Aroclor mixtures. For individual samples in which none of the Aroclor mixtures are detected, total PCBs will be given a value equal to the highest RL of the Aroclors and assigned a U-qualifier (no detected concentrations).

- Total low-molecular-weight PAHs (LPAHs), high-molecular-weight PAHs (HPAHs), PAHs, and benzofluoranthenes will also be calculated in accordance with the methods of the SMS. Total LPAHs will be the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Total HPAHs were the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Total benzofluoranthenes will be the sum of the b (i.e., benzo(b)fluoranthene), j, and k isomers.

  Because the j isomer is rarely quantified, the total benzofluoranthenes sum will be typically calculated with only the b and k isomers. In cases where the laboratory provides total benzofluoranthenes instead of or in addition to the b and k isomers, the laboratory result will be reported, and no sum will be calculated. For samples in which all individual compounds within any of the three groups described above are non-detected, the highest RL for that sample will represent the sum.

- Total DDTs will be calculated using only detected values for the DDT isomers: 2,4′-dichlorodiphenyldichloroethane (DDD); 4,4′-DDD; 2,4′-dichlorodiphenyldichloroethylene (DDE); 4,4′-DDE; 2,4′-DDT; and 4,4′-DDT. For individual samples in which none of the isomers are detected, total DDTs will be given a value equal to the highest RL of the six isomers and assigned a U-qualifier (no detected concentrations).

- Total chlordane will be calculated using only detected values for the following compounds: alpha-chlordane, gamma-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor. For individual samples in which none of these compounds are detected, total chlordane will be given a value equal to the highest RL of the five compounds listed and assigned a U-qualifier (no detected concentrations).

- Total xylene will be calculated using only detected values for m,p-xylene and o-xylene. For individual samples in which neither of these compounds are detected, total xylene will be given a value equal to the higher RL of the two compounds listed and assigned a U-qualifier (no detected concentrations).

- Total nitrosamines will be calculated using only detected values for n-nitrodiethylamine, n-nitrosodimethylamine, n-nitroso-di-n-butylamine, n-nitroso-di-n-propylamine, and n-nitrosodiphenylamine. For individual samples in which none of these compounds are detected, total nitrosamines will be given a value equal to the highest RL of the five compounds listed and assigned a U-qualifier (no detected concentrations).

3.5 CALCULATION OF PCB CONGENER TOXIC EQUIVALENTS

PCB congener TEQs will be calculated using the World Health Organization (WHO) consensus toxic equivalency factor (TEF) values for mammals (Van den Berg et al. 1998; Van den Berg et al. 2006), as presented in Table 1. The TEQ will be calculated as the sum of each PCB congener concentration multiplied by the corresponding TEF value. When the PCB congener concentration is reported as non-detected, then the TEF will be multiplied by one-half the RL.

Table 1. PCB congener TEF values

PCB Congener No.	TEF Value for Mammals (unitless)[a]
77	0.0001
81	0.0003
105	0.00003
114	0.00003
118	0.00003
123	0.00003
126	0.1
156	0.00003
157	0.00003
167	0.00003
169	0.03
189	0.00003

[a] From Van den Berg et al. (2006).
PCB – polychlorinated biphenyl
TEF – toxic equivalency factor

3.6 CALCULATION OF DIOXIN/FURAN CONGENER TEQS

Dioxin/furan congener TEQs will be calculated using the WHO consensus TEF values for mammals (Van den Berg et al. 1998; Van den Berg et al. 2006) as presented in Table 2. The TEQ will be calculated as the sum of each dioxin/furan congener concentration multiplied by the corresponding TEF value. When the dioxin/furan congener concentration is reported as non-detected, then the TEF will be multiplied by one-half the RL.

Table 2. Dioxin/furan congener TEF values

Dioxin/Furan Congener	TEF Value for Mammals (unitless)[a]
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,6,7,8-HpCDD	0.01
1,2,3,4,7,8,9-HpCDF	0.01

Dioxin/Furan Congener	TEF Value for Mammals (unitless)[a]
1,2,3,4,7,8-HxCDF	0.1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,7,8-PeCDF	0.03
1,2,3,7,8-PeCDD	1
2,3,4,6,7,8-HxCDF	0.1
2,3,4,7,8-PeCDF	0.3
2,3,7,8-TCDF	0.1
2,3,7,8-TCDD	1
OCDF	0.0003
OCDD	0.0003

[a] From Van den Berg et al. (2006).

HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
OCDD – octachlorodibenzo-*p*-dioxin
OCDF – octachlorodibenzofuran
PeCDD – pentachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
TCDD – tetrachlorodibenzo-*p*-dioxin
TCDF – tetrachlorodibenzofuran
TEF – toxic equivalency factor

3.7 CALCULATION OF CARCINOGENIC POLYCYCLIC AROMATIC HYDROCARBONS

cPAH values will be calculated using potency equivalency factor (PEF) values (California EPA 2009) based on the individual PAH component's relative toxicity to benzo(a)pyrene. PEF values are presented in Table 3. The cPAH will be calculated as the sum of each individual PAH concentration multiplied by the corresponding PEF value. When the individual PAH component concentration are reported as non-detected, then the PEF will be multiplied by one-half the RL.

Table 3. cPAH PEF values

cPAH	PEF Value (unitless)[a]
Benzo(a)pyrene	1
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Chrysene	0.01
Dibenz(a,h)anthracene	0.4
Indeno(1,2,3-cd)pyrene	0.1

[a] PEFs for cPAHs are defined by California EPA (2009) by dividing the inhalation unit risk factor for the compound by the inhalation unit risk factor for benzo[a]pyrene.

cPAH – carcinogenic polycyclic aromatic hydrocarbon

EPA – US Environmental Protection Agency

PEF – potency equivalency factor

3.8 TOC NORMALIZATION

For comparison to benthic cleanup goals, sediment samples with TOC content < 0.5% or > 3.5% will not be TOC normalized for comparison to the organic carbon-normalized RALs and SMS criteria (Ecology 2015). When TOC normalization is not possible and the dry weight concentration is greater than lowest apparent effects threshold (LAET) and less than or equal to 2LAET, the concentration will be considered to be greater than sediment cleanup objectives (SCOs)[3] and less than or equal to the cleanup screening level (CSL).

[3] SCO, as defined in the 2013 SMS Rule (Washington Administrative Code [WAC] 173-204-562), is equivalent to the term sediment quality standard (SQS) used in the RI/FS (Windward 2010; AECOM 2012).

3.9 CALCULATION OF RECONSTITUTED WHOLE-BODY TISSUE FOR CRAB AND CLAMS

Reconstituted whole-body crab tissue concentrations will be calculated using Equation 1:

$$C_{WB} = \left(C_{hepatopancreas} \times f_{hepatopancreas}\right) + \left(C_{ediblemeat} \times f_{ediblemeat}\right) \qquad \textbf{Equation 1}$$

Where:

C_{WB} = estimated whole-body tissue concentration (mg/kg ww)

$C_{hepatopancreas}$ = hepatopancreas tissue concentration (mg/kg ww)

$F_{hepatopancreas}$ = average fraction of whole-body weight that is hepatopancreas (average hepatopancreas weight fraction of individual crab that are included in composite sample)

$C_{edible\ meat}$ = edible meat concentration (mg/kg ww)

$F_{edible\ meat}$ = average fraction of whole-body weight that is edible meat (average edible meat fraction of individual crab that are included in composite sample)

Reconstituted whole-body clam tissue concentrations will be calculated using Equation 2:

$$C_{WB} = \left(C_{siphonskin} \times f_{siphonskin}\right) + \left(C_{remainder} \times f_{remainder}\right) \qquad \textbf{Equation 2}$$

Where:

C_{WB} = estimated whole-body tissue concentration (mg/kg ww)

C_{siphon} = siphon skin tissue concentration (mg/kg ww)

F_{siphon} = average fraction of whole-body weight that is siphon skin (average siphon skin weight fraction of individual clams that are included in composite sample)

$C_{remainder}$ = remaining body concentration (mg/kg ww)

$F_{remainder}$ = average fraction of whole-body weight that is the remaining body (average remaining body fraction of individual clams that are included in composite sample)

For reconstituted whole-body concentrations that include a non-detected value for at least one tissue type composite, the non-detected value(s) will be represented in the calculation by one-half the detection limit; the final reconstituted whole-body result will be treated as a detected result. In cases where all tissue type composites are non-detected values, the final reconstituted whole-body result will be assigned a U-qualifier (no detected results), and the weighted sum of the detection limits for the two components will be used to represent the non-detected whole-body concentration.

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